EARLY DIFFERENTIATION, LATE MAGMATISM, AND RECENT BOMBARDMENT ON THE SHERGOTTITE PARENT PLANET

L.E. Nyquist and D.D. Bogard, *NASA Johnson Space Center*
J.L. Wooden, H. Wiesmann, C.-Y. Shih, and B.M. Bansal, *Lockheed Electronics Corp. Inc.*
G. McKay, *National Research Council, Houston, TX 77058*

Rb-Sr ages (T) and initial $^{87}Sr/^{86}Sr$ (I) for the shergottites, Shergotty and Zagami, and for the related achondrite ALHA 77005 are: Shergotty: T = 165 ± 12 m.y., I = 0.72261 ± 13; Zagami: T = 184 ± 8 m.y., I = 0.72139 ± 5; ALHA 77005: T = 183 ± 12 m.y., I = 71039 ± 5. The equality of these ages and the occurrence of maskelynite in these meteorites, coupled with older ^{39}Ar-^{40}Ar and Sm-Nd ages of Shergotty, imply that the Rb-Sr ages were reset by a single major impact on the shergottite parent body.

A pyroxene-whole rock Sm-Nd age of 620 ± 170 m.y. and a maximum whole rock ^{39}Ar-^{40}Ar age of 626 ± 15 m.y. are probably good estimates of the crystallization age of Shergotty Sm-Nd model ages relative to an eucritic initial $^{143}Nd/^{144}Nd$ of 3.6, 3.5, and 2.8 g.y. for Shergotty, Zagami, and ALHA 77005, respectively, are upper age limits. Sm-Nd and Rb-Sr whole rock isochrons (~ 1.2 g.y. and ~ 5 g.y., respectively) are discordant and show that the meteorites cannot be comagmatic. An early differentiation of the Shergottite parent body is indicated by BABI Rb-Sr model ages of 4.8-5.1 g.y. for the three meteorites. A two-stage model yields $(Sm/Nd)_r/(Sm/Nd)_s >$ 1.27, 1.33, and 1.68 for Shergotty, Zagami, and ALHA 77005, respectively for $T_X > 0$ where r = rock, s = source, and x = crystallization. For $(Sm/Nd)_r/(Sm/Nd)_s \leqslant 2.2$, the upper limit achievable via pyroxene accumulation, the model yields $T_X \leqslant 2.8$, 2.6, and 1.2 g.y., respectively. Corresponding $(Rb/Sr)_r/(Rb/Sr)_s$ are 0.80-0.96. Thus, the two-fold variation in Rb/Sr between ALHA 77005 and the shergottites is inherited from distinct sources which were established early in the parent body's history. Early differentiation plus late magmatism imply a sizable parent planet. A portion of the planet's surface must be young. Mars fits these criteria.

ISOTOPIC CONSTRAINTS FOR THE EARLY EVOLUTION OF THE MOON

F. Oberli, J.C. Huneke, M.T. McCulloch, D.A. Papanastassiou, and G.J. Wasserburg, *The Lunatic Asylum, Division of Geological and Planetary Sciences, Caltech, Pasadena, CA 91125*

A synthesis of the early evolution of the moon and of the lunar highland crust is made on the basis of U-Th-Pb, Rb-Sr, K-Ar and Sm-Nd isotopic data from lunar highland breccias. These data indicate that most of the lunar highland rocks were metamorphosed during a short period of giant impacts at 3.8-4.0 AE (Terminal Lunar Cataclysm). The existence of an older major impact event at 4.17 AE is documented by precise, identical U-Pb and ^{40}Ar-^{39}Ar ages obtained from breccia 78155. This older event may be connected with the formation of a basin on the eastern part of the earth-facing side of the moon or on the lunar far-side.

Both 3.9 and 4.17 AE old breccias yield nearly identical primary U-Pb ages of 4.46 and 4.51 AE suggesting that the moon differentiated on a planetary scale at that time. Derivation of the highland breccias from *differentiated* sources is indicated by variations of initial Sr, Nd and Pb isotopic ratios at the times of impact metamorphism.

Rb-Sr model ages for KREEPUTh-rich breccias require Rb/Sr fractionation at times $\leqslant 4.2$ AE. Most likely the fractionation occurred during the cataclysm at ~ 3.9 AE. A volatile/refractory element fractionation mechanism does not appear to be the principal process involved. It is most plausible that the KREEP component was generated by partial melting of a source with high Rb/Sr.

CORRELATED ANOMALIES OF TELLURIUM AND XENON IN ALLENDE

L.L. Oliver, R.V. Ballad, J.F. Richardson, and O.K. Manuel, *Department of Chemistry, University of Missouri, Rolla, MO 65401*

The relative abundances of ^{120}Te, ^{122}Te, ^{123}Te, ^{124}Te, ^{126}Te, ^{128}Te and ^{130}Te in carbon- and spinel-rich fractions of Allende's acid etched residues have been redetermined by neutron activation and γ-ray spectrometry. Changes from the procedure described by Ballad *et al.* (1979) are (i) irradiation to a higher neutron fluence, (ii) analysis of Te from a sample of natural sylvanite, Cripple Creek, CO, (iii) use of the ingrowth activity of ^{131}I to monitor levels of ^{131}Te in the irradiated samples and monitors, and (iv) use of a computerized peak-stripping program for data reduction. No differences were observed between the isotopic compositions of Te in the monitor of purified TeO_2 and the sample of sylvanite.

The spectra of even mass Te isotopes in the carbon- and spinel-rich fractions of Allende are shown in Figure 1, normalized to the second lighest stable isotope, ^{122}Te.

$$g^{i}_{122} = ({}^{i}Te/{}^{122}Te)_{Sample}/({}^{i}Te/{}^{122}Te)_{Monitor} \qquad (1)$$

In addition to the six isotopes shown there, the activity produced by double neutron capture on ^{123}Te indicates values of $g^{123}_{122} = 2.5 \pm 0.8$ and $- 0.6 \pm 0.8$ for the carbon and spinel fractions, respectively.

To illustrate similarities in the anomaly patterns of Te and Xe in these residues, the Xe spectra reported by Ballad *et al.* (1979) have been